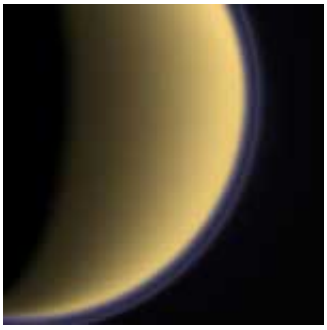
More Stormy Weather on Titan

December 22 2004



Titan, it turns out, may be a very stormy place. In 2001, a group of astronomers led by Henry Roe, now a postdoctoral scholar at the California Institute of Technology, discovered methane clouds near the south pole of Saturn's largest moon, resolving a debate about whether such clouds exist amid the haze of its atmosphere.
Now Roe and his colleagues have found similar atmospheric disturbances at Titan's temperate mid-latitudes, about halfway between the equator and the poles. In a bit of ironic timing, the team made its discovery using two ground-based observatories, the Gemini North and Keck 2 telescopes on Mauna Kea, in Hawaii, in the months before the Cassini spacecraft arrived at Saturn and Titan. The work will appear in the January 1, 2005, issue of the Astrophysical Journal.

"We were fortunate to catch these new mid-latitude clouds when they first appeared in late 2003 and early 2004," says Roe, who is a National

Science Foundation Astronomy and Astrophysics Postdoctoral Scholar at Caltech. Much of the credit goes to the resolution and sensitivity of the two ground-based telescopes and their use of adaptive optics, in which a flexible mirror rapidly compensates for the distortions caused by turbulence in the Earth's atmosphere. These distortions are what cause the well-known twinkling of the stars. Using adaptive optics, details as small as 300 kilometers across can be distinguished despite the enormous distance of Titan (1.3 billion kilometers). That's equivalent to reading an automobile license plate from 100 kilometers away.

Still to be determined, though, is the cause of the clouds. According to Chad Trujillo, a former Caltech postdoctoral scholar and now a scientist at the Gemini Observatory, Titan's weather patterns can be stable for many months, with only occasional bursts of unusual activity like these recently discovered atmospheric features.

Like Earth, Titan's atmosphere is mostly nitrogen. Unlike Earth, Titan is inhospitable to life due to the lack of atmospheric oxygen and to its extremely cold surface temperatures (-297 degrees Fahrenheit). Along with nitrogen, Titan's atmosphere also contains a significant amount of methane, which may be the cause of the mid-latitude clouds.

Conditions on Earth allow water to exist in liquid, solid, or vapor states, depending on localized temperatures and pressures. The phase changes of water between these states are an important factor in the formation of weather in our atmosphere. But on Titan, methane rules. The moon's atmosphere is so cold that any water is frozen solid, but methane can move between liquid, solid, and gaseous states. This leads to a methane meteorological cycle on Titan that is similar to the water-based weather cycle on Earth.

While the previously discovered south polar clouds are thought to be a result of solar surface heating, the new mid-latitude clouds cannot be

formed by the same mechanism. One possible explanation for the new clouds is a seasonal shift in the global winds. More likely, says Roe, surface activity might be disturbing the atmosphere at the mid-latitude location. Geysers of methane slush may be brewing up from below, or a warm spot on Titan's surface may be heating the atmosphere. Cryovolcanism--volcanic activity that spews an icy mix of chemicals--is another mechanism that could cause disturbances. Hints about what is happening on this frigid world could be obtained as the Huygens probe, which will be released from Cassini on Christmas day, drops through Titan's atmosphere in January 2005.

If the clouds are being caused by these geological conditions, says Roe, they should stay at the observed 40-degree latitude and repeatedly occur above the same surface feature or features. Meanwhile, if a seasonal shift in the winds is forming the clouds then their locations should move northward as Titan's season progresses into southern summer. "Continued observations with the Gemini and Keck telescopes will easily distinguish between these two scenarios," says Roe.

The Gemini observatory is operated by the Association of Universities for Research in Astronomy under a cooperative agreement with the National Science Foundation, involving the National Optical Astronomy Observatory, AURA, and the NSF as the U.S. partner. The W.M. Keck Observatory is operated by the California Association for Research in Astronomy, a scientific partnership between the California Institute of Technology, the University of California, and the National Aeronautics and Space Administration.

Source: California Institute of Technology

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